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"Acoustical Imaging of Laser Generated Ultrasound Using a Spatio-Temporal Processing Approach"

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ABSTRACT: In this paper we discuss an application of spatio-temporal array signal processing techniques applied to broadband ultrasonic data gathered from a pulsed laser system. Using a laser source to heat a material specimen under test for flaws, we apply a spatio-temporal processor capable of estimating the displacement field of the specimen. The peak surface displacement is displayed as an image showing the initial source (displacement field) propagating throughout the material as well as any flaws (scatterers) that may be present within the specimen. Clearly, this method of imaging enables a unique methodology for nondestructive evaluation (NDE). Here a pulsed laser generates an acoustic (ultrasonic) wave by heating the material and causing a thermoelastic expansion. The resulting ultrasonic wave propagates throughout the material and is received by an array of interferometers created synthetically. Assuming a spherically propagating wave-field, the processor creates an image of the field by estimating the peak surface displacement at a given location. The resulting image displays valuable information about the material and its inherent flaws providing an effective method for nondestructive evaluation. In this work we show the results of apply this method to data synthesized from a sophisticated thermoelastic simulation as well as test specimens available in the laboratory.

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